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Our Case No. 5050/787

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)	
Sriram Krishnan	)	
Serial No. 09/650,942	)	Examiner: A. Imam
Filing Date: August 30, 2000	)	
For MEDICAL ULTRASONIC IMAGING PULSE TRANSMISSION METHOD	)	Group Art Unit: 3737

AMENDMENT

United States Patent and Trademark Office
P. O. Box 2327
Arlington, Virginia 22202

Honorable Commissioner:

Please enter the following amendments in response to the Office Action of October 23, 2001.

In the Claims

Please amend Claims 1, 2, 7 and 8 as follows. The attached appendix includes a copy of the amended claims, in which amendments are highlighted with underlining and square bracketing.

1. A medical ultrasonic imaging pulse transmission method comprising:

(a) transmitting with an ultrasonic imaging system a set of at least three ultrasonic pulses with a transducer array comprising N transducer elements, said set of pulses comprising K subsets of pulses, each subset characterized by a respective transmit phase, at least two of the transmit phases differing from one another, each of the pulses of the set comprising a respective aperture, the apertures of at least two of the pulses differing in number of active transducer elements;

(b) selecting the apertures used in (a) such that each transducer element n is active for a total of A(n) pulses in each of the subsets.

2. A medical ultrasonic imaging pulse transmission method comprising:

(a) transmitting with an ultrasonic imaging system a set of at least three ultrasonic pulses with a transducer array comprising N transducer elements, said set of pulses comprising K subsets of pulses, each subset characterized by a respective transmit phase, at least two of the transmit phases differing from one another, each of the pulses of the set comprising a respective aperture, the apertures of at least two of the pulses differing in number of active transducer elements;

(b) during (a), activating each transducer element n for a total of A(n) times during each of the K subsets.

7. The method of Claim 1 or 2 further comprising:

(c) receiving echo signals from the pulses in the set; and

(d) combining the echo signals.

8. The method of Claim 7 wherein (d) substantially cancels a fundamental component of the echo signals.

REMARKS

In the outstanding Office Action, Claims 1-10 were rejected under 35 U.S.C. § 112 as indefinite and under 35 U.S.C. § 103(a) as unpatentable over the prior art. The following sections take up these rejections in sequence.

The Rejection of Claims 1-10 Under 35 U.S.C. § 112

In response to this rejection, Applicant has amended independent Claims 1 and 2. Applicant submits that amended Claims 1 and 2 clearly define two method acts (a) and (b). Additionally, in view of the amendments to Claims 1 and 2, Applicant has amended Claims 7 and 8 for consistency.

Applicant submits that the outstanding rejection under 35 U.S.C. § 112 has been overcome, and that it can now be withdrawn.

The Rejection of Claims 1-10 as Unpatentable Under 35 U.S.C. § 103

In this rejection, the claims have been rejected as unpatentable over the combination of at least three separate patents. Before turning to the rejections, the following discussion will first review one example from the specification.

The specification as filed provides non-limiting examples of the claimed method. Note in particular the discussion at page 7, line 8 through page 10, line 9. The drawings illustrate one example in Figures 2-5. Note that in block 42 of Figure 2 a first pulse of positive polarity is transmitted with N/2 active transducer elements (using for example the left subaperture 50 of Figure 3.) In block 44 a second pulse of negative polarity is transmitted with N active transducer elements (using for example the full aperture 52 of Figure 4.) In block 46, a third pulse of positive polarity is transmitted with N/2 active transducer elements that were inactive during transmission of the first pulse (using for example the right subaperture 54 of Figure 5.) This is one non-limiting example of the way in which apertures can be selected such that each transducer element n is active for a total of A(n) pulses in each of the subsets. In this example, each transducer element is active only once in the subset including the first and third pulses and only once in the subset including the second pulse. Similarly, in this example each transducer element n is activated for a total of A(n) times during each of the two subsets. In this case A(n) is equal to 1 for each of the transducer elements.

All of the rejections are based on Averkiou as the primary reference. Applicant agrees that Averkiou discloses an ultrasonic imaging system that uses transmit pulses of high and low power. However, as noted by the Examiner in the outstanding Office Action, Averkiou fails to mention the use of subsets of pulses.

The secondary references Muzilla, Ramamurthy, and Hossack have been cited as disclosing ultrasonic imaging methods using transducer elements grouped in subsets or subapertures. However, the disclosed subsets and subapertures are quite different from the present invention. Note the multiple subapertures shown in Figures 23a, 23b, 23c, 24, 25, 28a, 28b and 28c of Ramamurthy, which are included in a single transmit pulse. Ramamurthy does not disclose transmitting with an ultrasonic imaging system a set of at least three ultrasonic pulses with a transducer array comprising N transducer elements, wherein the set of pulses comprises K subsets of pulses, each subset characterized by a respective transmit phase, at least two of the transmit phases differing from one another. Hossack relates to an ultrasound image registration system using a multiple array transducer probe. Once again, Applicant finds no suggestion in Hossack that a set of at least three ultrasonic pulses of the type defined by act (a) should be transmitted. Muzilla is submitted to be no more relevant than Ramamurthy or Hossack described above.

The outstanding Office Action also relies on Nakamura for the act of controlling a power source in order to provide appropriate voltage to the transducer elements so that differing transmit phases can be achieved. Nakamura discloses a voltage controller 26 which, as described at Column 5, lines 20-54, adjusts the output voltage to obtain the desired drive pulse voltage. Nakamura does not suggest that a set of at least three ultrasonic pulses having the characteristics defined by Claims 1 and 2 should be transmitted.

Applicant submits that the Examiner has pointed to no suggestion to one of ordinary skill in the art to combine the patents as relied on in the outstanding rejection. Absent such a suggestion to combine, the outstanding rejection is improper and should be withdrawn.

Furthermore, even if the proposed combination were made, the result would not be the invention defined by any of the rejected claims. Note, for example, the final paragraph of Claim 1 that calls for selecting the apertures used in act (a) such that each transducer element n is active for a total of A(n) pulses in each of the subsets. Also, note the last paragraph of Claim 2, which calls for activating each transducer element n a total of A(n) times during each of the K subsets. There is no suggestion in any of the

applied references of these features of the invention, either standing alone or in combination with the elements of act (a).

For all of the foregoing reasons, Applicant submits that independent Claims 1 and 2 are nonobvious and patentable over the applied references. Dependent Claims 3-10 provide many additional grounds for patentability, but Applicant submits that there is no need to discuss these dependent claims at this time, in view of the clear basis for allowance of independent Claims 1 and 2.

Conclusion

Applicant submits that in view of the foregoing amendments and remarks, all of the claims pending in this application are in condition for allowance. Reconsideration is respectfully requested.

Respectfully submitted,

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APPENDIX

1. A medical ultrasonic imaging pulse transmission method comprising:

(a) transmitting with an ultrasonic imaging system a set of at least three ultrasonic pulses with a transducer array comprising N transducer elements, said set of pulses comprising K subsets of pulses, each subset characterized by a respective transmit phase, at least two of the transmit phases differing from one another[;],

[(b)] each of the pulses of the set comprising a respective aperture, the apertures of at least two of the pulses differing in number of active transducer elements;

(b) [(c)] selecting the apertures [selected] used in (a) such that each transducer element n is active for a total of A(n) pulses in each of the subsets.

2. A medical ultrasonic imaging pulse transmission method comprising:

(a) transmitting with an ultrasonic imaging system a set of at least three ultrasonic pulses with a transducer array comprising N transducer elements, said set of pulses comprising K subsets of pulses, each subset characterized by a respective transmit phase, at least two of the transmit phases differing from one another[;],

[(b)] each of the pulses of the set comprising a respective aperture, the apertures of at least two of the pulses differing in number of active transducer elements;

(b) [(c)] during (a), activating each transducer element n for a total of A(n) times during each of the K subsets.

7. The method of Claim 1 or 2 further comprising:

(c) [(d)] receiving echo signals from the pulses in the set; and

(d) [(e)] combining the echo signals.

8. The method of Claim 7 wherein (d) [(e)] substantially cancels a fundamental component of the echo signals.